Health Consultation

Evaluation of Indoor Air Sampling Results (January 29-30, 2003)

Pacific Cleaners and Randy's Nutrition
Olympia, Thurston County, Washington

February 2, 2004

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

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Glossary

Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse noncancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on ATSDR's *minimal risk level* (MRL).

Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Indeterminate public health hazard	The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.

Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
Monitoring wells	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
No Observed Adverse Effect Level (NOAEL)	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
No public health hazard	A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.

Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Plume	A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
Remedial investigation	The CERCLA process of determining the type and extent of hazardous material contamination at a site.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Background and Statement of Issues

The Washington State Department of Health (DOH), in cooperation with the Thurston County Public Health and Social Services Department (TCHD) conducted an exposure investigation to evaluate whether tetrachloroethylene (PCE) and PCE-related chemicals may be present at levels of health concern inside Randy's Nutrition Center (Randy's). Randy's is a health foods store located adjacent to Pacific Cleaners, an active dry-cleaning business that uses PCE. Randy's is located at 3530 Pacific Avenue SE, in Olympia, Washington (Appendix B, Figures 1 and 2). DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Pacific Cleaners has a history of odor and health complaints. In October 1992, the Olympic Region Clean Air Agency (ORCAA) was contacted by a nearby business about odor and health concerns associated with Pacific Cleaners.[1] More recently, in December 2002 and January 2003, the owner of Randy's contacted ORCAA with similar concerns.[2] Because of these recent concerns, ORCAA conducted numerous inspections at Randy's and Pacific Cleaners, and confirmed the reported odors. During one of the inspections, using a portable HFC (Halogen Leak Detector), PCE was detected throughout Pacific Cleaners as well as outside the open shop doors. ORCAA also observed vapor leaks, open containers, and possible faulty temperature gauges that resulted in a number of violation notices and at least one fine.[2]

Because odors continued at Randy's after ORCAA was notified, the owner also contacted TCHD. In January 2003, TCHD sampled Randy's and Pacific Cleaners using a portable photo ionization detector (PID) calibrated for PCE. The PID detected contaminant vapor levels that exceeded health comparison values in both Pacific Cleaners and Randy's.

Following the PID sampling, TCHD collected indoor air samples using 6-liter Summa® canisters with preset flow control devices that allowed time-weighted samples to be collected over a 24-hour period. The samples were collected in the back of Randy's and in a classroom located between Randy's and Pacific Cleaners, from January 29-30, 2003, and were analyzed for volatile organic compounds (VOCs), including PCE. Atmospheric Analysis & Consulting, Inc. analyzed the samples for VOCs using EPA Method TO-15.

The canister sampling indicated that measured levels of PCE, trichloroethylene (TCE), methylene chloride, and numerous other VOCs exceeded corresponding health comparison values. (Table 1).[4] Methylene chloride and many of the other VOCs are most likely associated with localized sources, such as office supplies and nearby automobile emissions.

A consultant hired by Pacific Cleaners determined that the source of the PCE was a leak at their dry-cleaning machine. As a result of the leak, ORCAA directed Pacific Cleaners to repair the equipment. In late February, after repairs were made to correct the leak, the Washington Department of Labor and Industries (L&I) inspected Pacific Cleaners, and did not detect any PCE.[5] DOH understands that there have been no further odor complaints since then.

This health consultation evaluates the results of the Summa® canister air samples collected from January 29-30, 2003 by TCHD inside Randy's and the classroom between Randy's and Pacific Cleaners.

Discussion

Indoor air sampling results from samples obtained in January 2003 from Randy's and the classroom located between Randy's and Pacific Cleaners were screened using ATSDR, U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) health-based criteria (comparison values). Contaminant concentrations below comparison values are unlikely to pose a health threat, and were not further evaluated. Contaminant concentrations exceeding comparison values and background levels (chemicals of potential concern, or COPCs) do not necessarily pose a health threat, but were further evaluated to determine whether they are at levels that could cause adverse human health effects.

Indoor air sampling results

Indoor air sampling results revealed that PCE and TCE levels were much higher than the concentrations of other detected chemicals, and are the chemicals of potential concern. PID readings revealed contaminant vapor levels from 10,000 parts per billion (ppb) to 2,000,000 ppb in Pacific Cleaners, and from 1,100 ppb to 20,400 ppb in Randy's. The highest levels were measured in and around the dry-cleaning machine, and at the rear of the dry-cleaning business, near the ceiling vent.[3] It should be noted that a PID is a screening level instrument designed to provide an estimate of organic vapors present, not to precisely distinguish one ionizable gas (such as PCE) from another. Therefore, if there is more than one compound present, the PID will not provide an accurate concentration of a particular gas, only an approximate reading of total gas concentration. Results of 24-hour Summa® canister air samples revealed PCE levels from 4,617 micrograms per cubic meter ($\mu g/m^3$) to over 8,000 $\mu g/m^3$, while TCE levels ranged from 397 $\mu g/m^3$ to 468 $\mu g/m^3$ (Table 1).[4]

Methylene chloride and benzene were also detected above their respective health comparison values in both locations tested. However, the levels were low and were at or near background levels of these chemicals commonly present in urban indoor and ambient air (Table 1).[6, 7] Health risks from exposure to these two chemicals was estimated to be low, and will not be discussed further in the health consultation. A number of other VOCs were also found at low levels in indoor air. Many of these VOCs were expected, since they have many common sources, including cleaning supplies, office equipment, nail polish, paint, and gasoline among others. These other VOCs were either below health comparison values, or at background levels. As a

Background

Background is defined here as the amount of chemical(s) expected to be present in air without any known contribution from a particular source. The background levels cited in this health consultation were obtained from various indoor air studies conducted throughout urban areas of the U.S. Sources of back ground levels of PCE, TCE, and methylene chloride can include household products, recently dry-cleaned clothes, solvents, paints, etc.

result of these findings, only the potential health hazards posed by PCE and TCE will be discussed further in this health consultation.

Table 1.

Pacific Cleaners and Randy's Nutrition Center.

Chemicals detected in indoor air exceeding health comparison values and background indoor air values, January 29-30, 2003

(Units are in micrograms per cubic meter)

Chemical	Location		Comparison Value		Background Indoor Air Literature Values	Cancer Class
	Randy's back room (Summa® canister)	Classroom (Summa® canister)	Cancer	Noncancer		
methylene chloride	38.2	21.2	3 (CREG)	1,042 (chronic MRL)	6	EPA B2
benzene	3.2	4.8	0.1 (CREG)	30 (RfC)	10	EPA Group A
tetrachloroethylene (PCE)	8,113	4,617	NA	271 (chronic MRL) 15,000 ppb (LOAEL)	5 (Shah & Singh)[6]	NA
trichloroethylene (TCE)	468	397	NA	40 (NCEA RfC) 7,000 ppb (subchronic LOAEL)	0.7 (Shah & Singh)[6]	NA
toluene	10.6	13.6	NA	400 (RfC)	5.7 (HSDB/indoor air)	EPA Group D

Shaded cells = chemicals of potential concern further evaluated in the health consultation
NA = not available
CREG = ATSDR cancer risk evaluation guide
MRL = ATSDR minimal risk level
EPA = Environmental Protection Agency
RfC = Reference concentration
LOAEL = Lowest Observed Adverse Effect Level
Ppb = parts per billion
NCEA = National Center for Environmental Health
HSDB = Hazardous Substance Data Bank

Non-cancer effects evaluation

EPA Reference Concentration (RfC) and ATSDR Chronic Minimal Risk Level (MRL)

Inhalation reference concentrations (RfCs) and chronic minimal risk levels (MRLs) are concentrations of a chemical in air below which adverse noncancer health effects are not expected to occur over a lifetime of continuous (i.e., 24-hour per day) exposure.

To estimate the potential for noncancer health effects from exposure to PCE and TCE, the concentrations of these two chemicals were compared to their respective noncancer comparison value [EPA reference concentration (RfC) or ATSDR chronic minimal risk level (MRL)]. RfCs and MRLs are set well below the actual toxic effect level (i.e., lowest observed adverse effect level (LOAEL) or no observed adverse effect level (NOAEL) determined from those studies upon which they are based. This approach provides additional health protection to account for the uncertainty associated with setting these "safe" levels of exposure. As shown in Table 1, PCE and TCE levels in Randy's and the adjacent classroom exceed background levels and their respective MRL or RfC.

PCE is a manufactured compound widely used for dry-cleaning fabrics and as a metal degreaser. It is also used as an intermediate in the manufacturing of other products. It evaporates easily into the air, and has a sharp, sweet odor at high concentrations.[8] TCE is primarily used as a metal degreaser, particularly in the automotive and metals industries. It is a breakdown product of PCE and it is also found in some household products, such as typewriter correction fluid, paint removers, adhesives, and spot removers.[9]

The MRL for PCE is based upon neurobehavioral effects observed during a 10-year occupational study.[8] Other systemic health effects associated with exposure to high levels of PCE in air include hepatotoxic (liver) effects, reversible kidney damage, endocrine effects, reproductive, and developmental effects.[8, 10] TCE exposure is associated with many of the same health effects as PCE, including neurotoxicity, immunotoxicity, developmental toxicity, liver and kidney toxicity, and endocrine effects.[9, 10] The RfC for TCE is based on critical effects on the central nervous system, liver, and endocrine system.[10]

While levels of PCE and TCE in indoor air exceeded their respective MRL or RfC, indicating the possibility of adverse noncancer (i.e., central nervous system, liver, and endocrine) effects from continuous, long-term exposure, it should be noted that the levels were from 10 to 100 times lower than the actual levels that produced these effects in the relevant occupational and laboratory animal studies.[8, 9, 10, 11, 12]

Table 2. *Randy's Nutrition Center and adjacent classroom. Noncancer risks (hazard quotients) associated with chronic exposure to the maximum concentration of PCE and TCE measured in indoor air**

Chemical	Location	
	*Hazard Quotient (Randy's back room)	*Hazard Quotient (Classroom)
tetrachloroethylene (PCE)	6**	3.4**
trichloroethylene (TCE)	2.3**	2**

*Correction factor of 0.2 was used in the exposure calculations to account for the less than 24-hours/day, 7-days/week exposure frequency for an office worker (see Appendix B).
**Hazard quotient greater than 1 indicates a potential noncancer health risk (see Appendix B for health risk formulas). Of the detected chemicals, PCE and TCE accounted for all of the potential noncancer risks (i.e., hazard quotient greater than 1).

Cancer risk evaluation

Tetrachloroethylene (PCE)

Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that PCE may reasonably be anticipated to be a carcinogen.[8, 10, 12] The International Agency for Research on Cancer (IARC) has determined that it is probably carcinogenic to humans, based on limited human evidence and sufficient evidence in animals. EPA is currently reassessing PCE toxicity, and has not adopted a final position on the weight-of-evidence classification.[10, 12]

Although a number of human studies (primarily epidemiology studies of dry-cleaning workers) suggest the possibility of increased cancer incidences from exposure to PCE, particularly esophageal and bladder cancers, it has not been shown to definitively cause cancer in humans. Other cancers suspected of being associated with exposures to high levels of PCE include intestinal, pancreatic, lung, kidney, skin, colon, and lymphatic/hematopoietic cancer. PCE increased the incidence of hepatocellular tumors in laboratory mice after oral and inhalation exposure and mononuclear cell leukemia and kidney tumors in rats after inhalation.[8, 10, 12]

The California Environmental Protection Agency (Cal EPA) recently derived an inhalation unit risk for PCE that can be used to estimate cancer risk.[13] Using this value, the estimated increased risk of developing cancer, assuming continuous exposure over a working lifetime to the detected concentrations of PCE in indoor air, is from approximately two to four additional cancers in a population of 1,000 persons exposed (2×10^{-3} to 4×10^{-3}) (Table 3). Actual risks are probably much lower than this, as exposure to these levels are more likely to have occurred over a period of days or weeks, not years.

Trichloroethylene (TCE)

The NCEA is currently revising a human health risk assessment for TCE that will present EPA's most current evaluation of the potential health risks from exposure to this chemical. The

mechanistic information suggests some risk factors that may make some populations more sensitive, and that TCE could affect children and adults differently.[11]

Recent and extensive review of available data has led EPA to characterize TCE as "highly likely to produce cancer in humans." These findings are consistent with those of the International Agency on Research of Cancer (IARC, 1995) and the National Toxicology Program (NTP, 2000). This classification is based on sufficient evidence in animals and limited evidence in humans. The strongest evidence that TCE can cause cancer in humans comes from occupational studies that have found increases in lung, liver and kidney cancers in workers exposed over several years.[11]

In experimental rodent studies, high doses of TCE administered to mice resulted in tumors of the lungs, liver, and testes. Other possible cancers associated with exposure to high levels of TCE include cancer of the bladder, stomach, prostate, kidney, and pulmonary system.[9, 11] TCE cancer effects levels (CELs), which were derived from lowest observed adverse effects levels (LOAELs) in chronic-duration studies on rats and mice, ranged from 100,000 ppb to 600,000 ppb.[9, 11] TCE levels measured in indoor air in Randy's and the adjacent classroom were thousands of times lower than these CELs.

Although the data obtained from high-dose animal or worker exposure studies is not directly applicable to exposures at the these businesses, theoretical cancer risk estimates can be made based on this data. In order to estimate the increased cancer risk for persons assumed to be chronically exposed to the detected levels of TCE in indoor air, the current recommended EPA inhalation slope factor was used.[11] The estimated increased cancer risk from TCE exposure in the two locations tested is similar to the risk from exposure to PCE, approximately five additional cancers in a population of 1,000 persons exposed over a working lifetime (5×10^{-3}) (Table 3).

Table 3. *Randy's Nutrition and adjacent classroom*
*Estimated increased cancer risk associated with chronic exposure to the maximum concentration of PCE and TCE measured in indoor air**

Chemical	Location	
	Randy's back room	Classroom
tetrachloroethylene (PCE)	3.8E-3	2.2E-3
trichloroethylene (TCE)	6E-3	5E-3
Total increased cancer risk	**1E-2**	**7E-3**

*CF = 0.08 correction factor to account for the less than 24-hours/day, 7 days/week exposure frequency for an office worker (see Appendix B).

Data Limitations

It should be noted that the estimated exposures and risks presented above are based on the results of a single sampling event, and therefore may not represent levels under different conditions or times. The suspected source of the PCE and TCE was reportedly eliminated, so current levels are likely much lower, or nonexistent. However, as sampling data does not exist to confirm this conclusion, DOH recommends follow up confirmatory sampling.

Chemical mixtures

It is plausible that trichloroethylene and tetrachloroethylene jointly act in an additive manner to impair nervous system function. There is no evidence to indicate that these chemicals jointly act on the nervous system in a less-than-additive or greater-than-additive mode.[14]

The effect of tetrachloroethylene on trichloroethylene's liver and kidney toxicity was projected to occur by a less-than-additive joint action based on *in vivo* evidence that tetrachloroethylene inhibits the metabolism of trichloroethylene in humans under occupational exposure conditions, and evidence that trichloroethylene and tetrachloroethylene act in a less-than-additive manner to cause liver and kidney peroxisomal proliferation. In summary, the available data provide no evidence of greater-than-additive interactions among trichloroethylene or tetrachloroethylene that might cause liver and kidney effects to occur.[14]

A component-based hazard index approach that assumes additive joint toxic action and uses ATSDR MRLs based on neurological impairment is recommended for exposure-based assessments of possible health hazards from exposure to mixtures of trichloroethylene and tetrachloroethylene. There is no evidence to indicate that greater-than-additive interactions would cause liver and kidney effects to occur at exposure levels lower than those influencing the nervous system.[14]

Quantitative estimates (total estimated increased cancer and non-cancer risks) from exposure to all of the chemicals listed in Table 1 were also evaluated. TCE and PCE accounted for almost all of the increased risk.

Child Health Considerations

ATSDR recognizes that infants and children may be more vulnerable to exposures than adults when faced with contamination of air, water, soil, or food.[15] This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

Laboratory animal studies involving high dose exposures to the chemicals of concern (PCE and TCE) detected in indoor air in Randy's, the adjacent classroom, and Pacific Cleaners can result in reproductive and/or developmental effects. For example, studies of animals exposed *in utero* (via oral exposure of mothers) indicate that PCE can adversely influence the developing nervous system, but studies to examine possible associations between occupational exposure of humans to PCE and increased risks for birth defects in offspring or reproductive effects such as menstrual disorders and spontaneous abortions provide only suggestive evidence that these types of effects may occur in humans (ATSDR 1997).

Since direct or indirect exposures to the unborn, infants and young children inside these businesses are expected to be infrequent, DOH considers the risks to be minimal. In addition, the levels of PCE and TCE that produced developmental and reproductive effects in the relevant toxicity studies were considerably higher than the levels detected inside the businesses.

Conclusions

A previous, short-term drycleaning machine leak inside Pacific Cleaners is the likely source of measured levels of PCE and TCE in Randy's Nutrition Center and a classroom situated between Pacific Cleaners and Randy's. A consultant hired by Pacific Cleaners evaluated the leak, which appears to have been mitigated. As a result, current levels are likely much lower, or nonexistent.

Estimated exposures and health risks discussed in the health consultation are based on the results of a single sampling event, and therefore may not represent levels under different conditions or times. Based on the results of this single sampling event, an elevated health risk could have existed in the past, assuming a twenty-five year working lifetime exposure to the measured levels of PCE and TCE. Pending the results of follow up, confirmatory sampling, the businesses tested (Pacific Cleaners, Randy's, and the classroom) are categorized as an indeterminate public health hazard.

1. As a result of odor complaints and health concerns expressed by the owner of Randy's Nutrition Center (Randy's), in December 2002 and January 2003, staff from the Olympic Region Clean Air Agency and Thurston County Environmental Health Division inspected Pacific Cleaners and Randy's Nutrition, and conducted indoor air sampling. Screening-level sampling revealed VOCs in indoor air in Pacific Cleaners, Randy's, and an adjacent classroom situated between Pacific Cleaners and Randy's that exceeded health comparison values.

2. More sensitive follow-up sampling conducted on January 29-30, 2003 inside Randy's and the adjacent classroom revealed elevated levels of PCE and TCE in indoor air. Measured levels posed no immediate or short-term health concern.

3. The January 29-30 sampling revealed lower levels of other chemicals in Randy's and the adjacent classroom, but below or near ambient background levels and below levels of health concern. Many of these chemicals were expected, since they have many common sources, including cleaning supplies, office equipment, nail polish, paint, and gasoline among others.

4. Long-term exposure to PCE and TCE levels detected in indoor air indicates a moderate to high increased cancer risk (i.e., a cancer risk significantly greater than what is normally expected). However, this risk assumes persons were exposed continuously for twenty-five years to the maximum detected concentrations of these chemicals. Because the source of the measured PCE and TCE levels appears to have been a short-term leak originating from Pacific Cleaner's dry-cleaning machine, the length of exposure (hence the risk) is most likely much lower.

5. Long-term exposure to the maximum levels of PCE and TCE detected in indoor air could cause mild neurological impairment and adverse effects on the liver and kidneys for persons assumed to be exposed continuously. Although the levels exceeded their respective MRL and RfC, PCE levels were from 12 to 22 times lower than the lowest

level that produced these effects in the relevant studies (the LOAEL), while TCE levels were from 80 to 95 times lower than the LOAEL. As indicated above, because the source of the elevated PCE and TCE levels appears to have been a short-term leak originating from Pacific Cleaner's dry-cleaning machine, the length of exposure (hence the risk) is likely much lower.

Recommendations/Action Plan

1. Follow-up indoor air sampling should be conducted to assure that the suspected source of the PCE and TCE has been eliminated, and that current concentrations are below levels of health concern.

   Action Proposed

   - DOH will work closely with TCHD and the business owners to coordinate appropriate follow-up indoor air sampling in Randy's Nutrition, the adjacent classroom, and possibly Pacific Cleaners. If follow-up sampling is conducted, DOH will evaluate the results in a separate health consultation.

2. Adequate ventilation should be maintained within the business work areas to promote dispersion and reduce the accumulation of chemical vapors.

   Action Proposed

   - DOH and TCHD will discuss this with the owners/operators of Randy's and Pacific Cleaners.

3. Dry-cleaning equipment should be properly maintained to assure that liquid and vapor leaks do not occur.

   Action Proposed

   - DOH will contact TCHD and ORCAA, and the owners of Pacific Cleaners to confirm that all equipment leaks have been repaired.

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Appendix A: Figures

Appendix B

Health Risk Formulas and Exposure Assumptions

The formulas and parameters provided below were used to conservatively estimate cancer and noncancer health risks. It is important to note that EPA RfC and IUR values, and ATSDR MRLs assume continuous exposure.

Hazard Quotient using RfCs and MRLs

$HQ = C_a/(RfC \text{ or } MRL) \times CF$

HQ = hazard quotient (unitless)
C_a = indoor air concentration (ug/m^3)
RfC = Reference concentration (ug/m^3)
MRL = Minimal Risk Level (ug/m^3)
CF = correction factor of 0.2 (8/24 x 5/7 x 50/52) to account for the less than continuous (i.e., 8 hours/day, 5 days/week, 50 weeks/year) exposure scenario assumed for a worker.

Cancer risk using unit risk factors

$\text{Cancer risk} = C_a \times IUR \times CF$

C_a = indoor air concentration (ug/m^3)
IUR = inhalation unit risk (per ug/m^3)
CF = correction factor of 0.08 (8/24 x 5/7 x 50/52 x 25/75) to account for the less than continuous (i.e., 8 hours/day, 5 days/week, 50 weeks/year, 25 years) exposure scenario assumed for a worker.

Cancer risk using slope factors

$\text{Cancer risk} = ((C_a /1000) \times IR \times EF \times ED/(BW \times AT)) \times CSF$

C_a = indoor air concentration in micrograms/m^3
IR = inhalation rate (adult worker - 10.4 m^3/day)
EF = exposure frequency (250 days/year)
ED = exposure duration (25 years)
BW = body weight (72 kg)
AT = averaging time (27,375 days)
CSF = chemical-specific cancer slope factor

Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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